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Bongberg

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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
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A COMPARISON OF RESULTS OBTAINED BY DIRECT AND INDIRECT METHODS OF BARK BEETLE CONTROL IN THE BURNEY AREA, SHASTA COUNTY, CALIFORNIA DURING 1946

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INTRODUCTION

In some years bark beetle populations reach epidemic proportions in many western forest areas and direct measures for artificial control become necessary to protect the timber against additional loss. During 1944 two species of Ips engraver beetles, Ips grandi Eich., and Ips sanfluens Lec., reached epidemic levels in the ponderosa pine timber in portions of the Burney Area, Shasta and Siskiyou counties, California, and felling, peeling, and burning of infested trees was undertaken as a measure of control. State, private, and federal agencies joined in cooperation to combat this epidemic and during the course of the project 26,700 acres were treated at a total cost of $37,800.00. Where possible, the merchantable portions of the infested trees were removed to a local saw mill for utilization.

As judged by the amount of beetle-caused loss which occurred on the controlled area the following year, the program of control was appraised as highly successful and the objectives of the project were fulfilled. However, because of an infestation by the western pine beetle, Dendroctonus brevicomis Lec., which persisted in a portion of the control area, direct control on a maintenance basis was undertaken in 1946 in order that the benefits gained during the previous year could be preserved pending application of indirect control measures by means of a sanitation-salvage cutting. The maintenance control program in 1946 was justified in as much as (1) the money expended in 1945 should be protected by additional control and losses held to a minimum until indirect control through sanitation-salvage logging could be undertaken on the area treated; and (2) an assurance to the timber owners that every effort was being made to reduce timber losses in this area to an absolute minimum.

Contrary somewhat to the original intentions for control in 1946 the program evolved into the use of the following measures: (1) direct control by felling, peeling, and burning the infested trees on a portion of the area which had been treated in a similar manner the previous year; (2) indirect control through the use of sanitation-salvage cuttings (removal of high risk and currently infested trees) where no control had been attempted previously; and (3) indirect control as mentioned in (2) above, modified by added protection in peeling and burning the infested tops, breaks, and cull logs that were left after logging in a "zone of maintenance" surrounding the Burney Falls State Park. The location of the control treatments are shown on the appended map.

The program of control as employed in 1946 presented an excellent opportunity to test the effectiveness of direct and indirect methods in reducing subsequent loss under similar conditions of infestations and areas. It is the purpose of this report to review the control procedures and compare the results obtained by direct and indirect methods that were applied to the infestation in 1946.

THE CONTROL OPERATIONS DURING 1946

Fell-peel-burn maintenance control. T. 36 N., R. 3 E., M. D. M.

During 1944, timber loss resulting from Ips engraver beetles and the western pine beetle in this area was estimated to average 163 board feet per acre. Direct fell-peel-burn control abated this high level of loss and reduced the infestation to 31 board feet per acre in 1945. Control on a maintenance basis was resumed on federal and private timberland holdings during 1946 as a means of preserving the protection gained from the 1945 operation. A summary of 1946 operation is given in Table 1.

Table 1

Summary of fell-peel-burn maintenance control in 1946. T. 36 N., R. 3 E., MDM

Ownership	Acres Spotted	Acres Treated	Trees Treated	Vol. bm Treated	Spotting Cost Tree	Spotting Cost Mbm	Spotting Cost Acre	Treating Cost Tree	Treating Cost Mbm	Treating Cost Acre
F.G.S. Co.*	4,240	2,560	116	116,630	$4.26	$4.24	$.12	$17.96	$22.10	$1.01
U.S.F.S.**	4,200	4,200	61	65,080	$2.79	$2.61	$.04	$11.12	$10.43	$0.16
Total	8,440	6,760	177	181,710						
Average					$3.75	$3.66	$.08	$15.60	$15.20	$0.33

* Fruit Growers Supply Company
** U. S. Forest Service

Indirect control by sanitation-salvage cutting. T. 35 N., R. 3 E., M. D. M.

One portion of the area which was included in the program of control in 1946 had been without protection from beetles during 1945 and timber losses were more severe here than elsewhere in the area. The record of loss during 1945 averaged 152 board feet per acre. In this area the timber was owned by one large operating company which elected to attempt control by sanitation-salvage cuttings in order to secure longer lasting protection from beetles, rather than expand direct treatment by the fell-peel-burn method. High risk and infested trees on 2,200 acres were marked for the cutting which began in March. A summary of the sanitation-salvage control program is given in Table 2.

Table 2

Summary of sanitation-salvage control. T. 35 N., R. 3 E., M. D. M.

		PINE TIMBER MARKED FOR SANITATION-SALVAGE CUTTING								
		HIGH RISK TREES			INFESTED TREES			TOTAL		
Location	No. of Acres	No. of Trees	Volume Mbm	Volume per Ac.	No. of Trees	Volume bm	Volume per Ac.	No.of Trees	Volume Mbm	Vol.bm per Ac.
Sec. 13	640	512	70,245	1,098	65	62,690	98	577	76,509	1,195
Sec. 14	640	389	66,858	1,045	108	97,070	152	541	76,565	1,196
Sec. 15	280	199	39,616	660	69	75,560	126	268	47,172	786
Sec. 23	320	167	24,713	772	53	47,410	148	220	29,454	920
Sec. 24	320	204	29,576	924	62	51,590	161	165	34,735	1,085
Total	2,200	1,471	231,003		357	334,320		1,971	264,435	
Average				1,050			152			1,202

Indirect control by modified sanitation-salvage logging. T. 36 N., R. 3 E., M. D. M.

Bark beetle control within the boundaries of the Burney Falls State Park is maintained annually to keep the infestation at a minimum in order to protect the aesthetic values in the park area. Little benefits could be expected as a result of annual control in the small state park without similar protection in the commercial timber lands nearby. To further protection against bark beetles in the park area, a "zone of maintenance" was established involving 2,400 acres of land in federal and private ownership surrounding the park area. It was the purpose here to control bark beetles on an annual basis similar to the protection and control within the park.

The program of control in the "maintenance zone" in 1946 varied with respect to methods used according to ownership involved. It was felt that long term protection against bark beetle infestations could best be secured by the removal of high risk trees. This action was possible only on 780 acres of lands owned by the Fruit Growers Supply Company. As an added benefit to the control effects of sanitation-salvage logging, all infested tops, breaks, and cull logs which remained after logging were peeled and burned in an effort to further reduce the infestation. A summary of the indirect control on the 780 acres within the "maintenance zone" is given in Table 3. On areas of federal and other private ownership, control in the "maintenance zone" was accomplished by fell-peel-burn methods. A summary of this action is given in Table 4.

Table 3

Summary of sanitation-salvage control. Burney Falls State Park Maintenance zone. T. 36 N., R. 3 E., M. D. M.

		PINE TIMBER MARKED FOR SANITATION-SALVAGE CUTTING								
		HIGH RISK TREES			INFESTED TREES*			TOTAL		
Location	Acres	No.of Trees	Volume Mbm	Volume per Ac.	No.of Trees	Volume bm	Volume per Ac.	No.of Trees	Volume Mbm	Volume per Ac.
Sec. 2	40	19	24,070	602	3	1,870	47	22	25,940	649
Sec. 3	360	309	299,320	831	50	58,770	163	359	358,090	995
Sec. 4	320	174	218,440	683	50	54,300	170	224	272,740	852
Sec. 5	60	40	55,530	926	2	2,590	43	42	58,120	969
Total	780	542	597,360		105	117,530		647	714,890	
Average				766			151			917

* Tops, breaks, and cull logs peeled and burned.

Table 4

Summary of direct fell-peel-burn control. Burney Falls State Park Maintenance Zone. T. 36 N., R. 3 E., M. D. M.

	Acres	Acres	Trees	Vol. bm	Spotting Cost			Treating Cost		
Ownership	Spotted	Treated	Treated	Treated	Tree	Mbm	Acre	Tree	Mbm	Acre
P.G.& E.*	1,320	160	11	6,210	$5.33	$9.34	$.04	$16.29	$37.64	$3.66
U.S.F.S.**	1,220	1,220	36	26,400	$2.83	$3.66	$.08	$ 9.70	$13.22	$2.86
Total	2,540	1,380	47	32,610						
Average					$3.42	$4.93	$.06	$11.24	$16.20	$3.43

* Pacific Gas and Electric Company
** U. S. Forest Service

COMPARISON OF CONTROL RESULTS

During 1946, subsequent to the control operations, a series of half-section sample plots were established in the areas treated by direct and indirect methods and in surrounding uncontrolled stands in order that losses subsequent to control could be compared to uncontrolled stands nearby. Supplementary loss data were obtained from roadside sample plots previously located in this area. The location of sample plots are shown on the appended map.

Fell-peel-burn maintenance control. T. 36 N., R. 3 E., M. D. M.

It was not expected that fell-peel-burn control in 1946 would reduce further the low level of loss which followed the initial action in 1945. The purpose of the program in 1946 was to preserve the benefits gained during the previous year and prevent any increase in losses pending plans and action

for long term protection through the use of indirect control by sanitation-salvage cuttings. A comparison of the 1946 infestation as determined from a cruise of sample plots on treated and check areas is given in Table 5. A comparison of the losses in 1945 and 1946 on the same sample plots is given in Table 6.

Table 5

Comparison of 1946 pine loss on fell-peel-burn maintenance control and virgin areas.

Status of Sample	Sample Plot Number	Acres in Sample	PINE LOSS IN 1946			
			No. of Trees	Volume bm per Tree	Volume bm	Volume bm/Acre
Maintenance	10	320	27	770	20,730	64.8
Control	11	320	21	1,220	25,650	80.2
Fell-peel-	12	320	13	1,100	14,280	44.6
burn	13	320	9	1,260	11,310	35.3
	14	320	9	1,030	9,300	29.1
	RD-1	320	17	410	6,890	21.5
	RD-2	280	13	1,270	16,510	59.0
	RD-3	56	3	720	3,580	63.9
	RD-4	128	11	650	7,190	56.2
	RD-5	112	3	2,160	6,470	57.7
	RD-6	32	0	0	0	0.0
	RES-4	20	0	0	0	0.0
	RES-7	20	4	1,100	4,400	220.0
	RES-9	20	0	0	0	0.0
Total		2,585	132		126,310	
Average				960		48.8
Virgin	4	240	2	875	1,750	7.3
	5	320	11	1,820	19,970	62.4
	6	320	16	1,130	18,060	56.4
	9	290	9	1,190	10,710	36.9
	RD-7	244	4	580	2,330	9.5
	RD-8	32	0	0	0	0.0
	RD-9	320	30	780	23,540	73.6
	RES-6	20	3	1,180	3,540	177.0
	RES-12	20	3	730	2,180	109.0
	RES-13	20	0	0	0	0.0
Total		1,626	78		82,080	
Average				1,050		45.0

Table 6

Comparison of 1945 and 1946 pine loss on fell-peel-burn control and virgin areas.

Status of Sample	Acres in Sample	Pine Loss in 1945 No.of Trees	Volume bm	Volume per ac.	Pine Loss in 1946 No.of Trees	Volume bm	Volume per ac.	Ratio of loss 1946/1945
Maintenance Control	2,588	158	146,600	56.6	132	126,310	48.8	0.86
Virgin	1,826	142	119,240	65.3	78	82,080	45.0	0.69

Table 5 shows that the average loss per acre in 1946 was approximately the same on treated and virgin areas, indicating that the fell-peel-burn control in 1946 was successful in preventing an increase in the trend of loss but did not reduce the infestation below the level which resulted from the control program in 1945. The comparison of losses in 1945 and 1946, as shown in Table 6, indicates that the current trend of the infestation was downward and a larger drop occurred in virgin areas than where direct control had been applied for two consecutive years.

Indirect control by sanitation-salvage cutting. T. 36 N., R. 3 E., M. D. M.

The purpose of indirect control through the use of sanitation-salvage cutting was to obtain protection against bark beetles for a longer period than could be secured from direct peel-burn methods. Also, control as a result of the selective removal of high risk trees would allow for the utilization of trees that could not be obtained by direct control treatment. The 1946 record and comparison of loss on sample plots in the sanitation-salvage control and virgin areas is given in Table 7. A comparison of loss in 1945 and 1946 on sample plots in the sanitation-salvage, peel-burn, and virgin areas is given in Table 8.

Table 7

Comparison of 1946 pine loss on sanitation-salvage control and virgin areas.

Status of Sample	Sample Plot Number	Acres in Sample	PINE LOSS IN 1946 No.of Trees	Volume per tree	Volume bm	Volume bm per Acre
Sanitation-Salvage Control	1	320	10	600	5,970	18.7
	2	320	5	170	850	2.7
	3	320	23	530	12,210	38.2
	RD-7	36	3	310	920	25.5
	RD-8	152	2	1,030	2,050	10.5
	RD-9	40	3	350	1,060	30.3
	RES-11	20	1	190	190	9.5
Total		1,208	47		23,250	
Average				480		19.2
Virgin (Total)		1,826	78		82,080	
(Average)				1,050		45.0

Table 8

Comparison of pine loss in 1945 and 1946 on sanitation-salvage control, fell-peel-burn control, and virgin areas.

Status of Sample	Acres in Sample	Pine Loss in 1945 No.of Trees	Volume bm	Volume per Ac.	Pine Loss in 1946 No.of Trees	Volume bm	Volume per Ac.	Ratio of Loss 1946/1945
Sanitation Salvage	1,208	174	153,620	127.2	47	23,250	19.2	0.15
Maintenance	2,588	155	146,600	56.6	132	126,310	48.8	0.86
Virgin	1,826	142	119,240	65.3	78	82,080	45.0	0.69

Table 7 shows that the pine loss during 1946 on the area treated by sanitation salvage control averaged 19.2 board feet per acre. On nearby virgin stands, the current loss averaged 45.0 board feet per acre, and on the area treated by fell-peel-burn methods, losses averaged 48.8 board feet per acre.

In order to estimate the reduction in loss which resulted from sanitation-salvage treatment it is necessary to take into account the normal fluctuation in the yearly trend of loss. By assuming that losses on the cut area, had no cutting been done, would follow the trend of loss on virgin areas, it

is possible to obtain an estimate of loss reduction as a result of the treatment by comparing losses on cut and uncut areas. The year 1945, the season preceding the sanitation-salvage operation, can be used as an index for subsequent comparisons. An estimate of loss reduction by the use of this comparison is given in Table 9.

Table 9

Estimate of reduction in loss as a result of sanitation-salvage cutting.

Year of Loss	Years Following Treatment	Computed Loss on Cut Area if Untreated: Trend of Infestation	Computed Loss on Cut Area if Untreated: Volume bm of Loss	Actual Loss on Cut Area after Cutting: Trend of Infestation	Actual Loss on Cut Area after Cutting: Volume bm of Loss	Volume bm Saved	% Reduction
1945	Base for comparison	100.0	153,620	100.0	153,620	0	0
1946	1st year	68.8	105,997	15.1	23,350	130,170	78.1

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For the first year following the sanitation-salvage treatment, losses were reduced on the cut area by 78.1 percent while the trend was normally downward. It is felt that greater benefits in control will be evident in subsequent years, particularly should loss trends turn upward.

Indirect control through modified sanitation-salvage cuttings.

In the area adjoining the State park where sanitation-salvage treatment was supplemented by direct control of parts of infested trees not logged, sampling of losses subsequent to the light logging was made by a cruise of 676 of the 780 acres treated. The record of loss for the first year following the treatment, and a comparison of losses in nearby virgin areas is given in Table 10. A comparison of loss between this area, the peel-burn control, the sanitation-salvage treatment, and the virgin area, is given in Table 11.

Table 9 -

105,997
- 23,350
82,647 is the amt. saved rather than 130,370 which is better labeled "reduction" since '45 includes the reduction due to normally declining infestation as well as effect of sanitation-salvage cutting)

Table 10

Comparison of 1946 pine loss on modified sanitation-salvage control and virgin areas.

Status of Sample	Location of Sample	Acres in Sample	PINE LOSS IN 1946 No.of Trees	Volume per Tree	Volume bm	Volume bm per acre
Modified	Sec. 2	88	0	0	0	0.0
Sanita-	Sec. 3	360	9	900	8,080	22.4
tion	Sec. 4	120	1	1,220	1,220	10.2
Salvage	RD-3	136	4	240	940	6.9
	RES-1	20	2	1,080	2,150	107.5
Total		676	16		12,390	
Average				770		18.3
Virgin (Total)		1,826	78		82,080	
(Average)				1,050		45.0

Table 11

Comparison of pine loss in 1945 and 1946 on modified sanitation-salvage control, maintenance fell-peel-burn control, sanitation-salvage control, and virgin areas.

Status of Sample	Acres in Sample	Pine Loss in 1945 No.of Trees	Volume bm	Volume per Ac.	Pine Loss in 1946 No.of Trees	Volume bm	Volume per Ac.	Ratio of Loss 1946/1945
A*	676	100	88,070	130.3	16	12,390	18.3	0.14
B*	2,588	158	146,600	56.6	132	126,310	48.8	0.86
C*	1,208	174	153,620	127.2	47	23,250	19.2	0.15
D*	1,826	142	119,240	65.3	78	82,080	45.0	0.69

A* Modified sanitation-salvage control.
B* Fell-peel-burn maintenance control.
C* Sanitation-salvage control.
D* Virgin areas.

A comparison of loss records from the areas where sanitation-salvage cutting was supplemented by peeling and burning of infested tops and cull logs with that of the sanitation-salvage cutting not given supplementary direct control treatment indicates that very little benefits in further reducing subsequent loss were obtained by the additional work in treating infested tops and logs left after logging. The record of loss between the two areas treated by sanitation-salvage logging differ by 0.9 board feet per acre. For that reason, no attempt is made here to estimate the reduction in loss as a result of treatment for this area alone.

SUMMARY AND CONCLUSIONS

An epidemic of tree killing bark beetles in the Burney Area, Shasta and Siskiyou counties, California, during 1944 made it necessary to initiate direct action to control the infestation. In a portion of the area, the infestation persisted during 1945 and measures of control were again undertaken in order to preserve the benefits obtained the previous year. This report reviews the control procedures and compares the results obtained by direct and indirect methods that were applied to the infestation in 1946.

The direct and indirect methods of control which were used in combatting the bark beetle infestation during 1946 are as follows:

(1) Direct control of infested trees by fell-peel-burn methods.

(2) Indirect sanitation-salvage control. (Selective cutting and subsequent logging and milling of high risk and infested trees.)

(3) Indirect modified sanitation-salvage control. (Selective cutting and subsequent logging and milling of high risk and infested trees plus supplementary control by peeling and burning of unmerchantable portions of infested trees (tops, breaks, and cull logs) left after logging.)

The results obtained in control by the use of direct and indirect methods was determined by comparing the occurrence of loss subsequent to treatment on each area to the occurrence of loss in nearby untreated stands. A summary of the comparison of results is as follows:

(1) Direct control by fell-peel-burn of infested trees on the area treated in a like manner the previous year prevented an increase in the current trend of loss but did not reduce the level of infestation below that obtained during 1945. These results substantiate findings from other direct fell-peel burn control operations in commercial "east side" timber stands, i.e., direct control is effective only in checking increasing infestations of an epidemic nature, and are not effective in further reducing a low endemic level of loss. In fact, it can be expected that losses on areas treated by fell-peel-burn methods will flare-up to epidemic proportions when direct control on a maintenance basis is abandoned. This is probable in that direct control allows for an accumulation of highly susceptible trees on an area and beetle populations are able to build up epidemic populations in this favored type of host material. By contrast, in undisturbed stands, various factors affecting population trends tend to reach a normal balance and a resulting normal endemic level of loss.

(2) Indirect control by sanitation-salvage cuttings reduced the amount of loss by 78.1 percent for the first year. In addition to the substantial reduction in loss resulting from the indirect treatment, the cutting, logging, and milling of high risk trees largely offset the cost of control treatment and allowed for the utilization of timber of little value in the form of snags or charred logs.

(3) Peeling and burning of unmerchantable portions of infested trees left after logging as a supplementary measure of control to the treatment by sanitation-salvage cutting alone did not give added control benefits. This result further demonstrates the needless expenditure of time, effort, and money in waging a campaign to control bark beetles by methods directed at destroying low populations.

A comparison of loss on areas treated by direct and indirect control methods is given in the following tabulation:

	Pine Loss - Bd.Ft./Acre	
	Before Control 1945	After Control 1946
Direct fell-peel-burn maintenance control	56.6	48.8
Indirect sanitation-salvage control	127.2	19.2
Indirect modified sanitation-salvage control	130.3	18.3
Virgin areas	69.3	45.0

From the comparison of results obtained by the use of direct and indirect methods of bark beetle control, it is concluded that the selective removal of high risk trees in sanitation-salvage cutting is to be preferred as a measure of bark beetle control in this area.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

BURNEY FLAT INSECT CONTROL UNIT
SHASTA COUNTY, CALIFORNIA

SCALE
0 1 2
MILES

Lake Britton
DAM
Fish Hatchery
State Park
Four Corners
STATE
Burney Spr. Mt.
Long Valley Mt.
Lookout 4532
30 Mt.
Black Ranch
DAM
Blue L.
Cr
RIM
HIGHWAY
DAM
Cr
T. 36 N.
3823
Brush Mt.
Transmission
Burney
Cr
Hat
Burney
BM 3111
BM 3254
WRL 9 46
R 3 E

LEGEND

BOUNDARIES
- UNIT
- SAMPLE PLOT
- BURNEY FALLS STATE PARK MAINTENANCE ZONE

- FELL-PEEL-BURN CONTROL 1945 & 1946
- SANITATION-SALVAGE CONTROL 1946 (BLUE = S.S. cut 1947)
- S-S CONTROL PLUS PEEL-BURN OF INFESTED TOPS AND CULL LOGS
- VIRGIN AREA
- (3) SAMPLE PLOTS
- CUTOVER LANDS AS OF 1/1/46